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TITLE: A SYSTEM FOR HANDLING PREFERABLY ELONGATED OBJECTS

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ABSTRACT:

CHG DATE=20021002 STATUS=O>The invention relates to a system for handling preferably elongate objects, including for used in the erection, demolition or repair of wind turbines, wherein the system comprises at least a hoisting appliance (6) and a wheel unit (2). The hoisting appliance (6) hookingly engages and hoists the object (12) at the one end; and the wheel unit (2) supports and guides the object (12) actively at the other end. By the wheel

unit (2) being self-propelled and remote-controlled, very accurate guidance and control is obtained during hoisting operations, wherein the object (12) is hoisted from or deposited on, respectively, its place of deposition, where the object (12) is to be brought from a preferably horizontal to a preferably vertical position or vice versa. Besides, the wheel unit (2) is used for transport by road of a part of the system.

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(54) Title: A SYSTEM FOR HANDLING PREFERABLY ELONGATED OBJECTS

(57) Abstract: The invention relates to a system for handling preferably elongate objects, including for used in the erection, demolition or repair of wind turbines, wherein the system comprises at least a hoisting appliance (6) and a wheel unit (2). The hoisting appliance (6) hookingly engages and hoists the object (12) at the one end; and the wheel unit (2) supports and guides the object (12) actively at the other end. By the wheel unit (2) being self-propelled and remote-controlled, very accurate guidance and control is obtained during hoisting operations, wherein the object (12) is hoisted from or deposited on, respectively, its place of deposition, where the object (12) is to be brought from a preferably horizontal to a preferably vertical position or vice versa. Besides, the wheel unit (2) is used for transport by road of a part of the system.

A SYSTEM FOR HANDLING PREFERABLY ELONGATED OBJECTS

The invention relates to a system and a method of handling preferably elongate objects, including for use in the erection, demolition or repair of wind turbines, wherein the system comprises at a hoisting appliance and a wheel unit.

For hoisting tasks in connection with the erection of wind turbines mobile cranes are primarily used today that are often of the self-propelled type. Such self-propelled crane is known in a simple version for instance from US 3,807,108 and is intended for many different types of hoisting operations. Including lifting with the crane boom at a low angle as well as lifting at a high angle relative to the horizontal. Self-propelled cranes being constructed exactly with a view to overall large applicability, the dimensions of such cranes become very large and heavy.

The size of the wind turbines constantly increasing and thus making continuously increasing demands to the lifting capacity and lifting height of the cranes, it means that the cranes become inconveniently large. For instance, in order to lift 25 ton to a height of 65 meters, it is necessary to use a 300-ton self-propelled crane. It may therefore require as much as a two-figured number of transport units to transport the entire crane. Included are additional boom sections, jibs (extensions), balance weights, etc. Of course it very costly to use so many transport units, and it raises problems with logistics.

It is a further aspect of the problem that it becomes very expensive to establish the roadbed that extends from public highways to the erection site the wind turbine. The larger the self-propelled cranes, the larger the requirements to the roadbed dimensions. In addition to the financial aspect, it may further be problematic from an environmental point of view to have such road structures.

Moreover, the very large and wide self-propelled cranes require dispensations from the Road Traffic Act and often they must be accompanied by an escort. Self-propelled cranes of the prior art type that are able to handle large wind turbines have a width in excess of 3 meters.

Another type of cranes that is known from hoisting operations in connection with the erection of wind turbines will appear from WO 9605391. This type of crane presupposes that the foundation of the wind turbine is configured such that the crane can also be secured thereto. The crane can be used without use of balance weights, all loads being transferred down into the foundation. The problem associated with this type of crane is that it is expensive to configure the foundation of the wind turbine such that there is also room for the crane to be there simultaneously with the turbine. Also following mounting, the part of the foundation that is used for securing the crane is of no use, unless the same crane is used again for demolition or repair. Besides, it is a drawback that yet a crane is required in order to enable erection of the crane for use.

When elongate objects, such as eg wind turbine towers, are to be erected from their horizontal position in which they are transported and to their vertical position in which they are to be installed, the crane usually hooks up at that end of the object that is to face upwards. This is practical once the object has been raised, but until one gets there, the object must be turned about a horizontal axis transversally to the longitudinal axis of the object. When the hoisting procedure with the crane is initiated, the elongate object will be supported in two points: by the crane at the one end and against the ground at the opposite end. When the lifting proceeds, the object is initially secured by friction against the ground at the end that is opposite the hooking point of the crane, whereby the other end will follow a circular arch with radius like the length of the object. Hereby the hooking point is also displaced in the horizontal plane, which means that the pull in the lifting wire of the crane is no longer vertical. Usually cranes are not intended or dimensioned for this. In order to avoid this situation, two cranes are often used that will, in

that case, engage at each their end of the object. The crane operators will then attempt to coordinate the hoist such that the object is turned and simultaneously shift the crane booms such that the pulls in both lifting wires are kept vertical. To say the least this is difficult, the crane operators being merely able to see whether the lifting wires are vertical in the one plane, whereas they are unable to see the other plane.

It is the object of the present invention to provide a system for handling preferably elongate objects, including for use in the erection, demolition or repair of wind turbines, that have easy and swift coordination and control of the lifting wire of the hoisting appliance being kept vertical during the entire hoisting operation, in order to thereby rationalise ia the erection process and reduce the amount of time consumed therein. It is a further reward that the system can be used in more difficult wind and weather conditions, ia due to the control of the load being more accurate. It is yet a further object of the invention to provide a system, wherein the structure of the hoisting device is dedicated to preferably elongate objects in order to thereby remedy the drawbacks of the above-described prior art techniques. That is to provide a system that can be transported on public highways without special dispensations; that makes minimal requirements to infrastructure necessary to reach the site of use; and that does not make special demands for/to foundation. It is yet an object to obtain a very rigid crane boom that has very low deflection whereby the load can be kept more still.

The novel system for handling preferably elongate objects distinguishes itself over the prior art in that the wheel unit is self-propelled and remote-controlled; and that the hoisting device hookingly engages and hoists the object at the one end and the wheel device actively supports and guides the object at the other end when the object is hoisted from or put down, respectively, on its place of unloading where the object is to be moved from a preferably horizontal to a preferably vertical position or vice versa.

Hereby it is obtained that by means of the remote control the crane operator is able to control the wheel unit and thus the one end of the object so accurately that he is not bound to a specific operating position and is thus able to move freely around and view the lifting wire in one or more planes, that the necessary correction of the hoisting position of the hoisting appliance is rendered completely or partially redundant. The crane operator is moreover able to control the crane with a remote control unit and thus to ensure a vertical lifting wire, since he is able to move freely and thus view the lifting wire in one or more planes.

By the wheel unit being able to be coupled to the object with a securing device, said securing device comprising means that allow rotation about at least one axis, it is accomplished that the object does not slide around on the wheel unit and that the wheel unit is able to control the position of the one end of the object without one or more undesirable moments of force being transferred from the wheel unit to the object, which could lead to undesired displacements at the other end of the object, and thus of the lifting wire of the hoisting appliance. This could be for instance in case of the support below the wheel unit being uneven or soft, whereby undesired turning of the wheel unit might occur, or other deviations relative to desired orientation and position that would then adversely influence the erection of the object.

The securing device comprising means that solely allow rotation about a horizontal axis enables transfer of moments of force to the object from the wheel unit. For instance in case of even, firm ground supporting the wheel unit, it may be desirable to be able to control the object more accurately, eg in case of more powerful wind influences.

The possibility of coupling the wheel unit to the hoisting device and using it during transport by road of the system makes it possible to save a wheel unit or a separate transport unit for the hoisting appliance.

Since the hoisting appliance is, during transport, divided into a boom unit and a support carriage with a top part, the two separate units are not longer or heavier than allowed by law.

As the wheel unit is coupled to the support carriage with top part, and as the boom unit is transported on a separate means of transportation, it is obtained that it is possible, in a simple manner, to mount the boom unit directly with the top part from the separate means of transportation without using crane or other lifting gear.

Since the hoisting appliance is provided with at least three support legs that extend horizontally so far that the use of a balance weight is minimised, it is obtained that the costly transport by road of a large and heavy balance weight is avoided.

By the support legs being connected to the hoisting appliance via bearings, said bearings allowing rotation in the horizontal plane, and the support legs being telescopic in their longitudinal direction, it is accomplished that the support legs consume very little space during transport and that they can expediently and without difficulty be swung out and telescoped in place in their in-use position.

The hoisting appliance sitting freely on the ground and not being secured to a foundation in connection with hoisting enables savings on the foundation, since it becomes less costly and it is also much faster to make the hoisting appliance ready for use.

The use of two independently hoistable wires being used simultaneously for the hoisting and the two wires not hooking onto the object in the same place enables the option of rotating the object in the air when it is clear of the place of deposition.

As the hoisting appliance comprises a crane boom that consists of a number of boom sections that are telescopic and can be locked independently of each other, it is obtained that the crane boom can be expelled to a length that corresponds to the relevant requisite lifting height; and that, during transport, the crane boom takes up as little space as possible.

The boom sections being provided with at least two inwardly facing guides, wherein the guides are integral parts of the profile of the boom sections, it is obtained that the boom sections can be welded in a convenient manner, whereby thrusts or other stress-related deformation is minimized. It is further obtained that the stability of the crane boom increases, as the guides divide the plate fields that constitute the sides of the boom sections.

The crane boom being telescoped by means of at least one telescopic cylinder that is provided with a carriage at the one end, and the inwardly oriented guides being used for conveyance of the carriage, ensures a reliable and efficient guidance of the end of the telescopic cylinder, which means that it can be configured in a less sturdy and lighter version.

The use of a method wherein the object is hooked and hoisted at the one end by means of a hoisting appliance and by the object being actively supported and controlled at the other end by means of a self-propelled and remote-controlled wheel unit, when the object is hoisted from or deposited in its position of deposition, respectively, where the object is to be caused to move from a preferably horizontal to a preferably vertical position or vice versa, enables the operator of the wheel unit to use the remote control to control the wheel unit and thus the one end of the object so accurately, due to his not being bound to a specific position of operation and thus being able to move freely around and view the lifting wire in several planes, that the requisite correction of the hoisting position of the hoisting appliance is rendered completely or partially redundant.

List of figures

Figure 1 shows the support carriage with top portion, ie hoisting appliance excluding boom unit, during transport by road;

Figure 2 shows separate transport by road of the boom unit;

Figure 3 shows the deposited support carriage with top portion, wherein wheel unit and front carriage are disconnected;

Figure 4 shows the coupling of support carriage to top portion and boom unit, which is accomplished without use of further lifting or hoisting appliances;

Figure 5 shows the hoisting appliance in its fully mounted state;

Figure 6 shows the hoisting appliance seen from above with the support legs in withdrawn and collapsed position;

Figure 7 shows the hoisting appliance with support legs in swung out and telescopically extended position;

Figure 8 shows the hoisting device with crane boom in erected position;

Figure 9 shows the hoisting device with crane boom in erected and fully telescopically extended position and the wheel unit with securing device mounted thereon;

Figure 10 shows the hoisting appliance and wheel unit hooked onto an elongate object;

Figure 11 shows the hoisting device and wheel unit during erection of an elongate object.

Figure 12 shows the hoisting device during hoisting of an object by use of two lifting wires;

Figure 13 shows a cross sectional view of the crane boom with the boom sections in telescopically withdrawn position;

Figure 14 is a cross sectional view of a boom section, wherein the telescopic cylinder is, in its carriage, conveyed by inwardly oriented guides in the profile of the crane boom.

Description of the drawing

Figure 1 shows a support carriage with top portion 1 during transport by road to the place of use. The rear end of the support carriage 1 rests on a wheel unit 2. Means may be mounted between the wheel unit 2 and the support carriage 1, whereby the wheel unit 2 is caused to participate in the steering during swinging. There may be used a separate front carriage 3 for the transport.

Figure 2 shows separate transport by road of the boom unit 4 that is accomplished by a separate means of transportation. 5.

Figure 3 shows the deposited support carriage 1 with top portion and the disconnected wheel unit 2. The wheel unit has its own means of advancement that may have an internal or external power supply. The wheel unit is also provided with a remote control to enable control by an operator who, it follows, does not necessarily have to be located in a specific location. Remote control and operator are not shown. The remote control may be coupled to the wheel unit 2 via a cord or the connection may be cordless.

Figure 4 shows coupling of the support carriage 1 to top portion and the boom unit 4. The wheel unit 2 being disconnected from the support carriage 1, there is room for the boom unit 4 to be taken directly to its place by means

of the separate means of transportation 5. Thus, the interconnection can be accomplished without the use of further hoisting or lifting appliances.

Figure 5 shows the completely mounted hoisting appliance 6. If it had been a hoisting appliance of smaller dimensions they could of course have been transported without being separated. Thus, merely practical considerations and statutory provisions decide the degree of separation for the transport. The hoisting device 6 is provided with a remote control to enable control by an operator who, it follows, does not necessarily have to be located in a specific location. Remote control and operator are not shown. The remote control may be coupled to the wheel unit 2 via a cord or the connection may be cordless.

Figure 6 shows the hoisting device seen from above. Support legs 7, 7.1 and 7.2 are in their withdrawn and collapsed position so as to consume as little space as possible for transport by road. Additionally, bearings 8.1 and 8.2 are shown.

Figure 7 shows the hoisting appliance 6 with support legs 7.1 and 7.2 in their swung-out and telescopically extended position. The support legs 7.1 and 7.2 can, in a preferred embodiment, be turned in the bearings 8.1 and 8.2, respectively. Instead they could, of course, also be loose and eg secured by screwing in their swung-out position. The same applies to the telescopic action that could likewise be accomplished by means of separate extender elements instead that could be secured in their extended positions eg by screws.

Figure 8 shows the hoisting unit 6 with its crane boom 9 in erected position, wherein the crane boom 9 is in its withdrawn position prior to telescopic action. This type of hoisting device is dedicated to very high lifts with the crane boom at a large angle. Thereby a far slimmer and lighter construction is obtained for the hoisting appliance that in case it was also to lift heavy loads at low angles, where the bending load is considerably higher. At a large

angle the bending loads are considerably reduced, whereas the pressure loads on the longitudinal direction of the crane boom 9 is increased comparatively.

Figure 9 shows the hoisting appliance 6 and the wheel unit 2. The wheel unit is mounted by means of the securing device 10.

Figure 10 shows the hoisting appliance 6 with the lifting wire 11, which is the principal wire, hooked onto the elongate object 12. The elongate object 12 is herein shown – as an example - as a section of a wind turbine tower, but of course it could be numerous other kinds of elongate objects, including eg transmission poles, lighting poles, columns for buildings, chimneys, Christmas trees, etc. The wheel unit 2 hooks onto the elongate object 12 with securing device 10. The securing device 10 allows rotation about at least one axis. Hereby it is obtained that the elongate object 12 can, while being erected, eg guided laterally, but is able to rotate freely at the back end about the axis/axes allowed by the securing device 10.

Telescopic action and locking of the boom sections of the crane boom 9 are not shown, but they are already known to the person skilled in the art, an exemplary embodiment being shown in EP 476,225 A2.

Figure 11 shows how the elongate object 12 is erected by means of the hoisting appliance 6 and the wheel unit 2. The operator of the hoisting appliance and the operator of the wheel unit will often be in radio-contact, for practical reasons. The crucial aspect during erection of the elongate object 12 is that the lifting wire 11 is at all times completely vertical. This may very advantageously be controlled by the two operators. The operator at the hoisting appliance sees to it that the hoisting rate is expediently fast or slow, whereby it is possible and practical for the operator at the wheel unit to control and check that the lifting wire 11 is at all times vertical. This is accomplished by displacing and guiding the rear end of the elongate object 12 by the wheel unit 2. This is accomplished very advantageously in that the

operator is not bound to a specific place of operation, but is able to move freely around with the remote control and select the place that will, at this particular point in time, require attention. According to a preferred embodiment the wheel unit is moved at a preferably fixed rate that is adapted to the lifting task in question, and the crane operator sees to it that the lifting wire is vertical seen in a first plane and the operator of the wheel unit guides in a second plane that is perpendicular to the first plane.

When the elongate object 12 has been raised to vertical, the securing device 10 is disconnected and the hoisting device 6 performs the handling on its own. The hoisting device 6 is able to turn its crane boom about a vertical axis and to change the angle whereby the elongate object can be located at a convenient site within the field of action of the crane. The hoisting operation should, to the extent possible, be performed within the range of the support legs 7, whereby use of counter weight can be minimised or avoided altogether. Hereby it is also achieved eg that it is avoided to couple the hoisting appliance to a foundation.

In Figure 12, the hoisting appliance 6 handles another elongate object 14, wherein the handling is accomplished without interaction by the wheel unit 2. In this case, the handling shown is that of the rotor of a wind turbine 14. This is intended as an example only, the use of the hoisting appliance being, as mentioned above, not restricted to wind turbines only. According to a preferred embodiment the object 14 is hooked by the lifting wire 11 in the centre of mass of the object and with the lifting wire 13 suitably displaced. The object 14 is lifted by means of the lifting wire 11 until it is suitably clear off the ground. Then the object 14 is turned by gradually pulling also the lifting wire 13 until the object is positioned vertically. In this manner it is obtained that the rotor can be mounted as an assembled unit on the nacelle of the wind turbine. By using two independently hoistable wires and the two wires not hooking the same point on the object enables rotation of the object in the air when it is clear off the site of deposition.

Figure 13 shows a section through the crane boom 9, wherein it is in its withdrawn state. The figure shows the profiles 16 of the sections. In the side of the profile that is constituted by the surfaces 18 and 19, inwardly oriented guides 17 have been inserted that constitute an integral part of the profile of the boom sections. According to a preferred embodiment a boom section 16 is constructed of two bent-up plates in the form of halves that are joined by welding at the guide 17. Hereby there is low deformation due to welding tensions due to the lateral rigidity of the guide 17. It is a further advantage that the welding is caused to be sitting in the neutral axis of the crane boom relative to the bending load, which means that the loads there from become small. It is also obtained that a high degree of lateral rigidity is imparted to the profiles, which is advantageous in relation to stability.

Figure 14 shows a telescopic cylinder 21 schematically depicted in the boom section 16, where it is conveyed by a carriage 20 that will, by means of rollers 22, be guided by the guides 17. Hereby it is obtained that the telescopic cylinder 21 can be configured in a much lighter and slimmer version, as it is supported more accurately during its movement back and forth (up and down) during telescopic action, than if it was merely supported by a wheel as taught in EP 476 22 A2.

The hoisting device 6 and the wheel device 2 are further provided with power and position sensors, including sensors that measure the angle or position of one or both lifting wires relative to the ground, the object or the wheel unit 2, from which signals can be deduced that can be used as input to a control computer, whereby the erection can be performed semi- or completely automatically. Besides, the signals can be used for alerting if the lifting wires deviate substantially from their vertical position.

Claims

1. A system for handling preferably elongate objects, including for use in the erection, demolition or repair of wind turbines, which system comprises at least a hoisting device and a wheel device, **characterised in** that the wheel unit is self-propelled and remote-controlled; and that the hoisting device hooks and hoists the object at the one end; and the wheel unit actively supports and controls the object at the other end when the object is hoisted from or deposited on, respectively, its site of deposition, where the object is to be brought from a preferably horizontal to a preferably vertical position or vice versa.

2. A system according to claim 1, **characterised in** that the wheel unit is coupled to the object by means of a securing device, said securing device comprising means that allow rotation about at least one axis.

3. A system according to claim 2, **characterised in** that the securing device comprises means that merely allow rotation about a horizontal axis.

4. A system according to any one of claims 1-3, **characterised in** that the wheel unit can be coupled to the hoisting appliance and used during transport by road of the system.

5. A system according to any one of claims 1-4, **characterised in** that the hoisting devise is, during transport, divided into a boom unit and a support carriage with top portion, whereby the two thus separate units are not longer or heavier than allowed by statutory provisions.

6. A system according to one of claims 1-5, **characterised in** that the wheel unit is coupled to the support carriage; and that the boom unit is transported on a separate means of transportation.

7. A system according to one of claims 1-6, **characterised in** that the hoisting appliance is provided with at least three support legs that extend horizontally so far that the use of a balance weight is minimised.

8. A system according to one of claims 1-7, **characterised in** that the support legs are connected to the hoisting device via bearings, said bearings allowing rotation in the horizontal plane; and that the support legs are telescopic in their longitudinal direction.

9. A system according to one of claims 1-8, **characterised in** that the hoisting device is sitting freely on the ground and is not secured to a foundation in connection with hoisting.

10. A system according to one of claims 1-9, **characterised in** that two independently hoistable wires are used simultaneously for the hoisting; and that the two wires do not hook onto the same place on the object, thereby enabling rotation of the object in the air when it is clear off the site of deposition.

11. A system according to one of claims 1-10, **characterised in** that the hoisting device comprises a crane boom that consists of a number of boom sections that can act telescopically and be locked independently of each other.

12. A system according to any one of claims 1-11, **characterised in** that the boom sections are provided with at least two inwardly facing guides, wherein the guides are an integral portion of the profile of the boom sections.

13. A system according to one of claims 1-12, **characterised in** that the crane boom is telescoped with at least one telescopic cylinder that is provided with a carriage at the one end; and that the inwardly facing guides are used to convey the carriage.

14. A method of handling preferably elongate objects, including for use in the erection, demolition or repair of wind turbines, **characterised in** that the object is hooked and hoisted at the one end by means of a hoisting appliance, and that the object is actively supported and guided at the other end by means of a self-propelled and remote-controlled wheel unit, when the object is hoisted form or deposited on, respectively, its site of deposition, where the object is to be brought from a preferably horizontal to a preferably vertical position or vice versa.

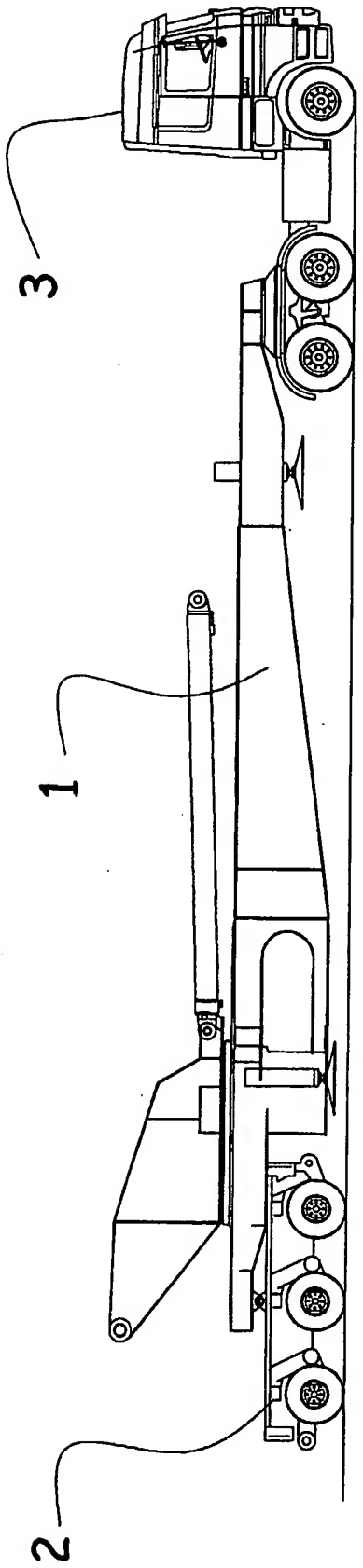

Fig. 1

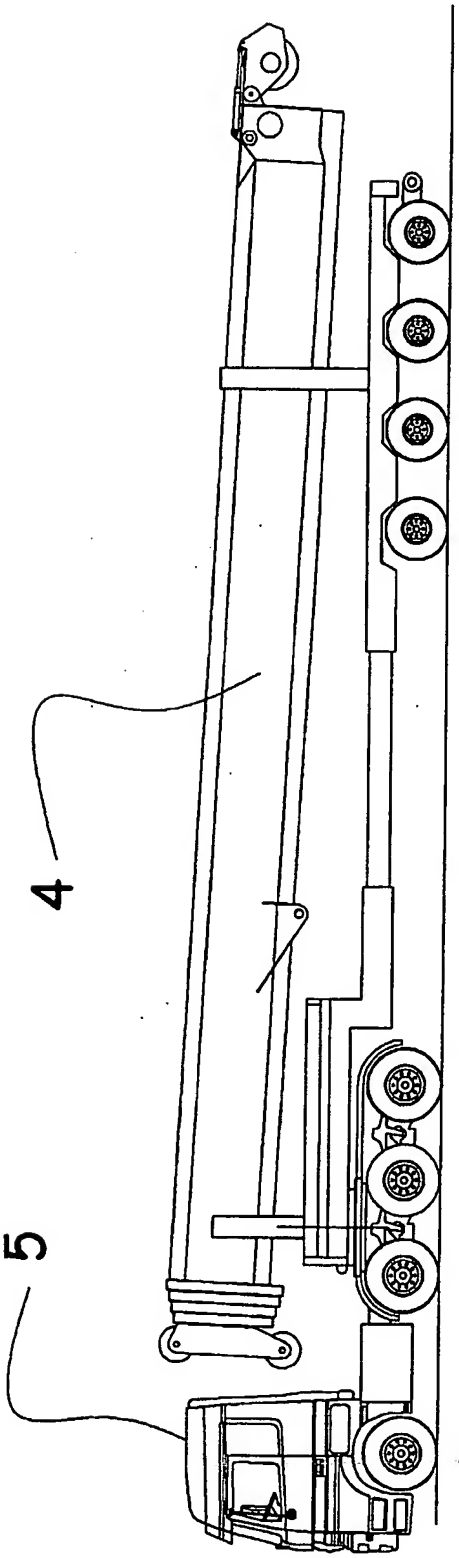

Fig. 2

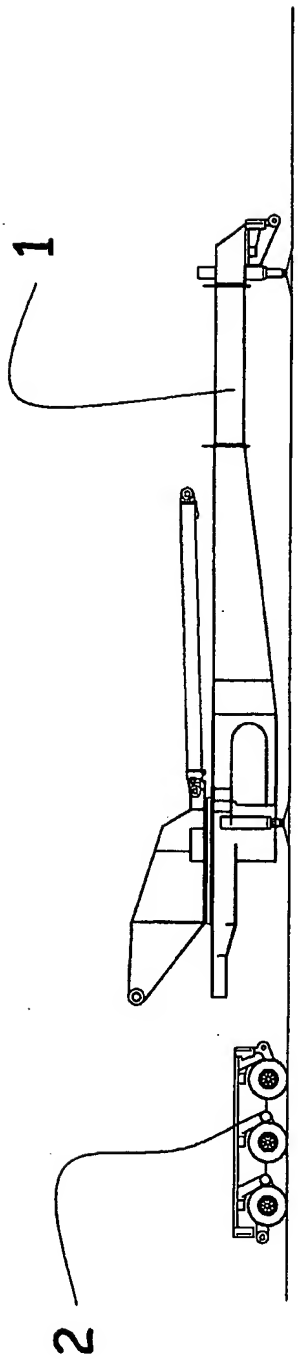

Fig. 3

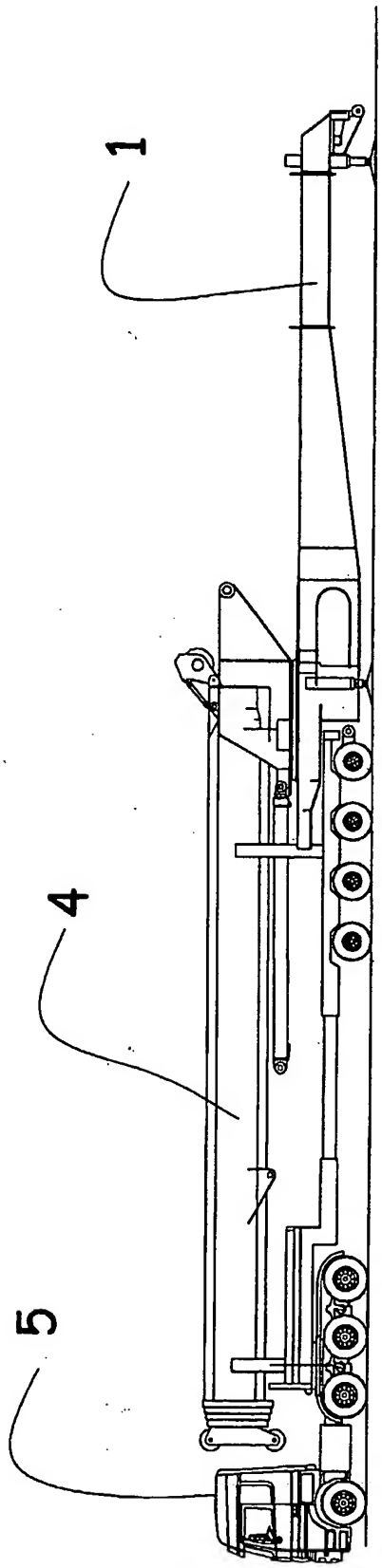

Fig. 4

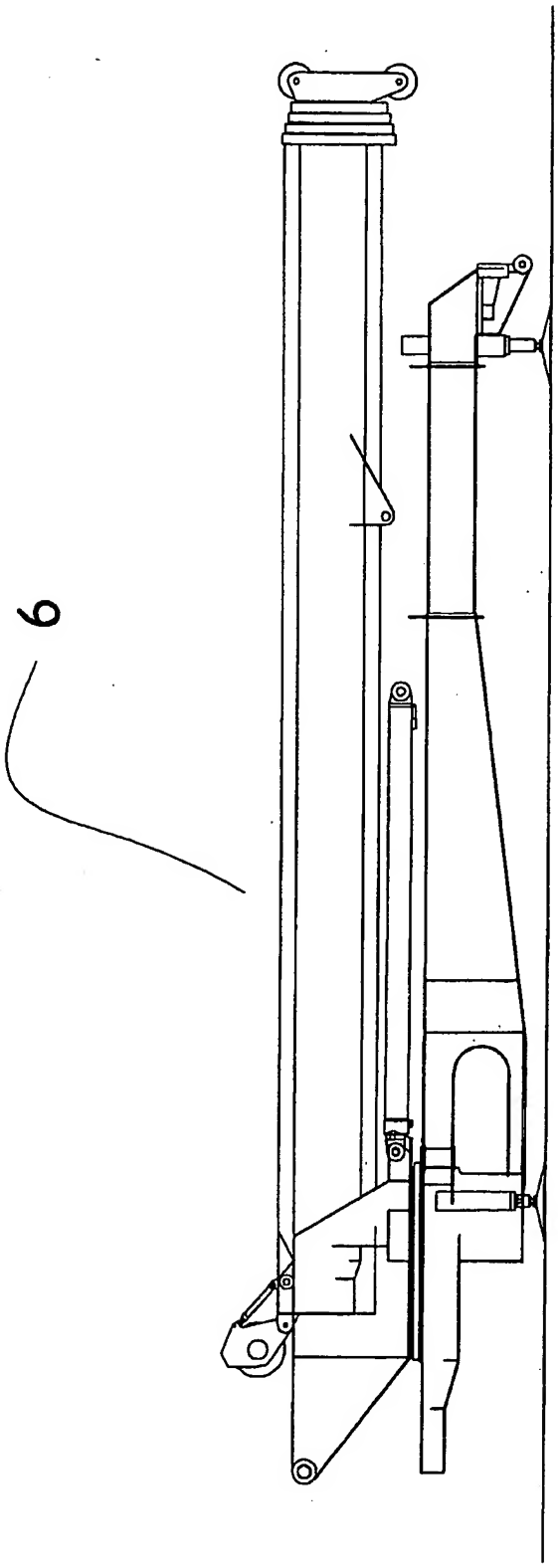

Fig. 5

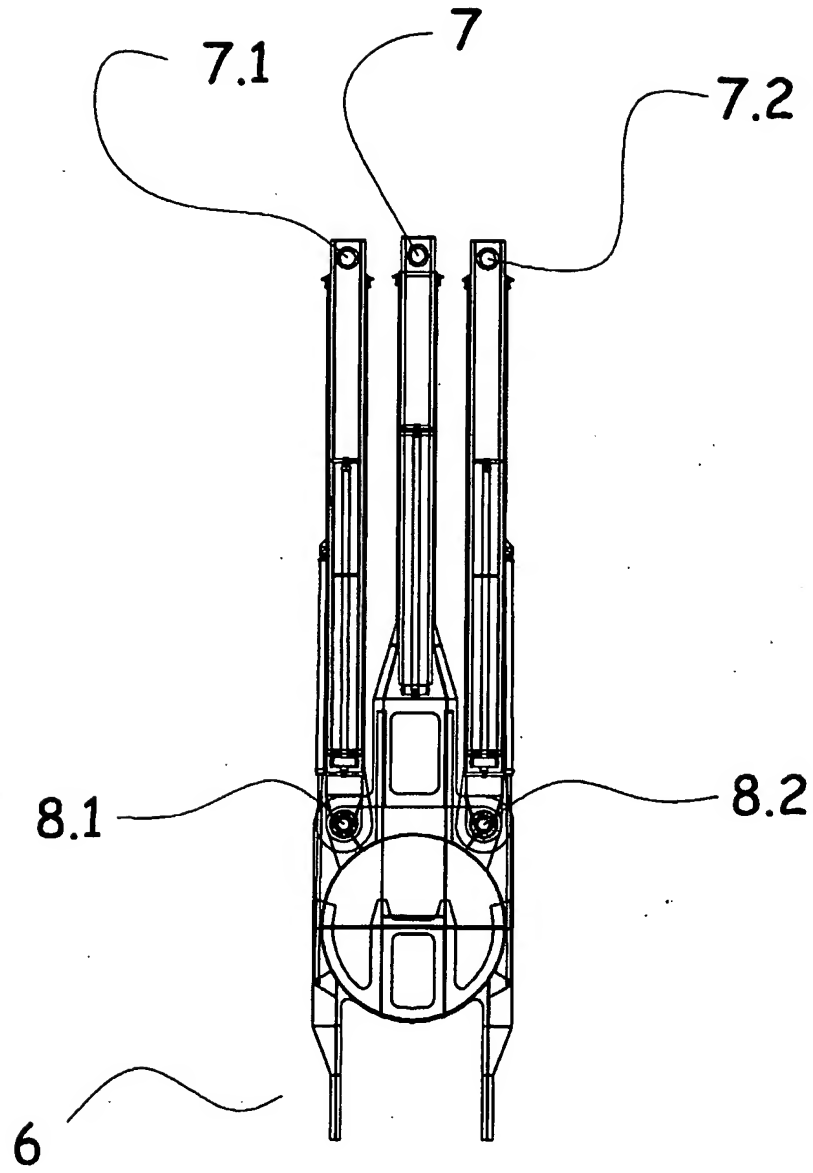

Fig. 6

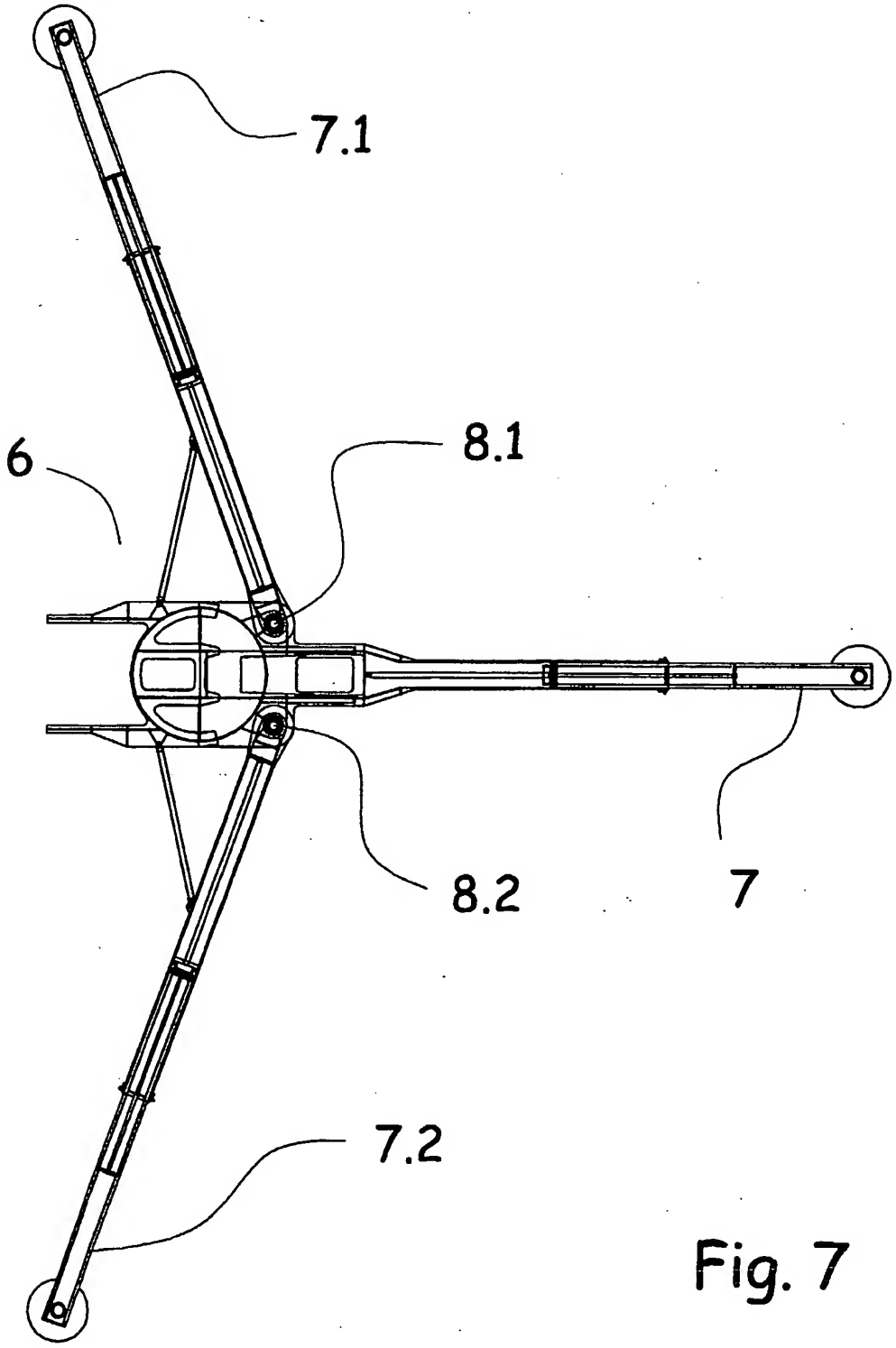

Fig. 7

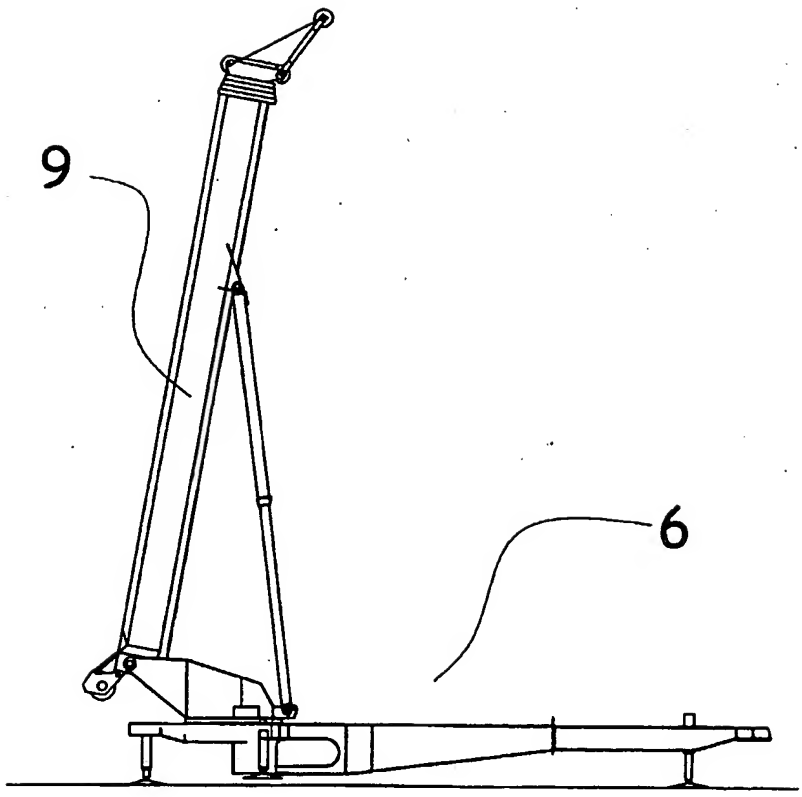

Fig. 8

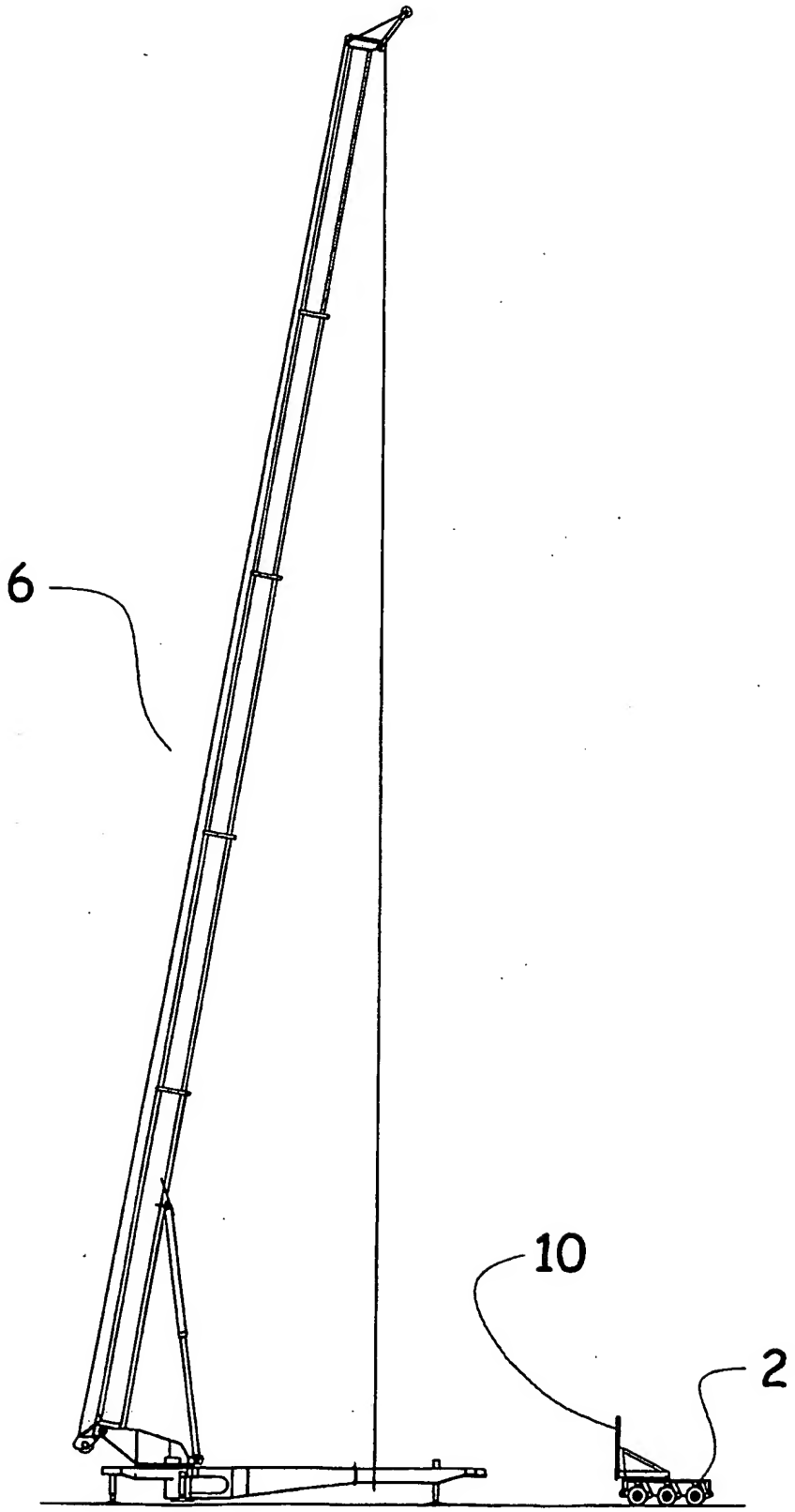

Fig. 9

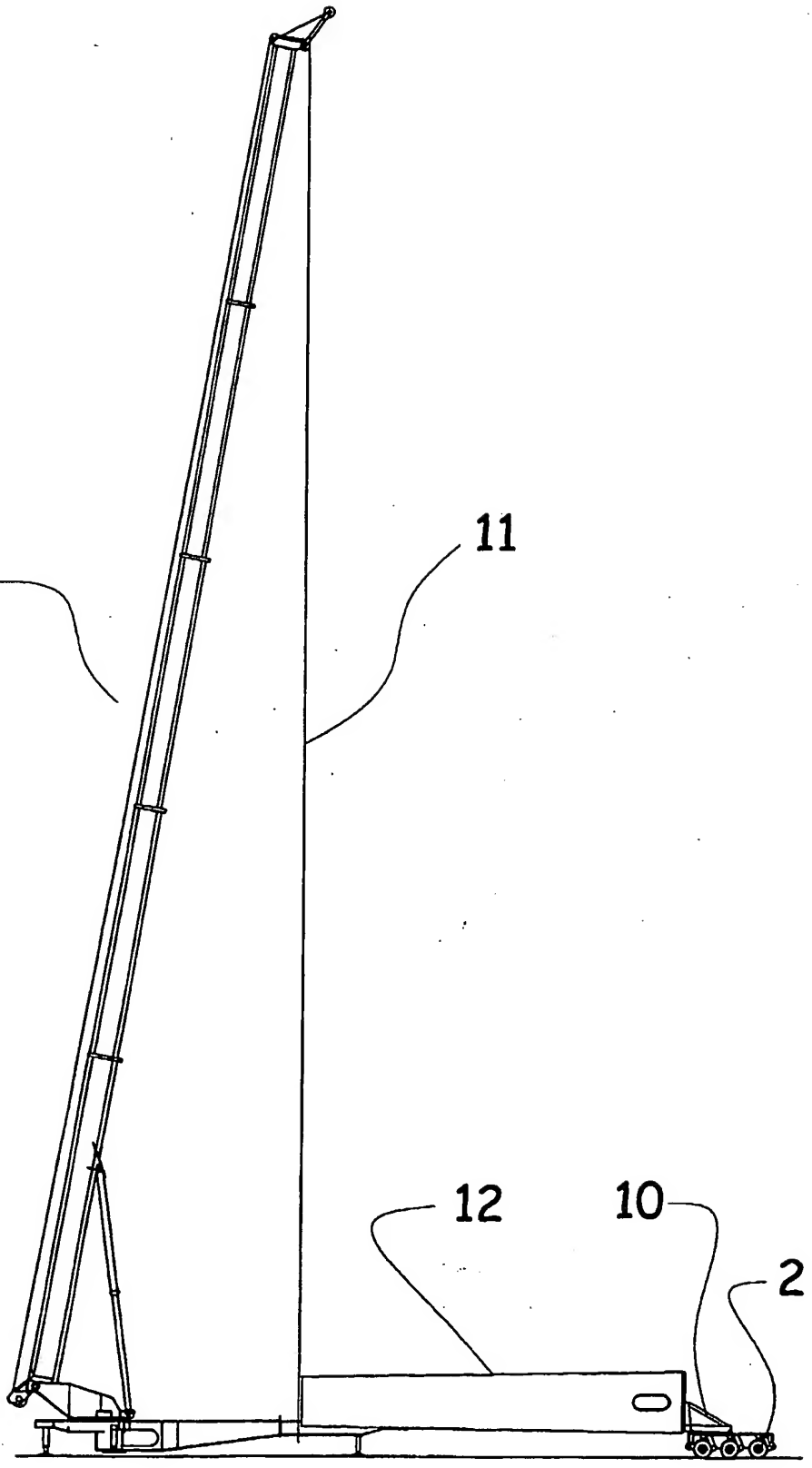

Fig. 10

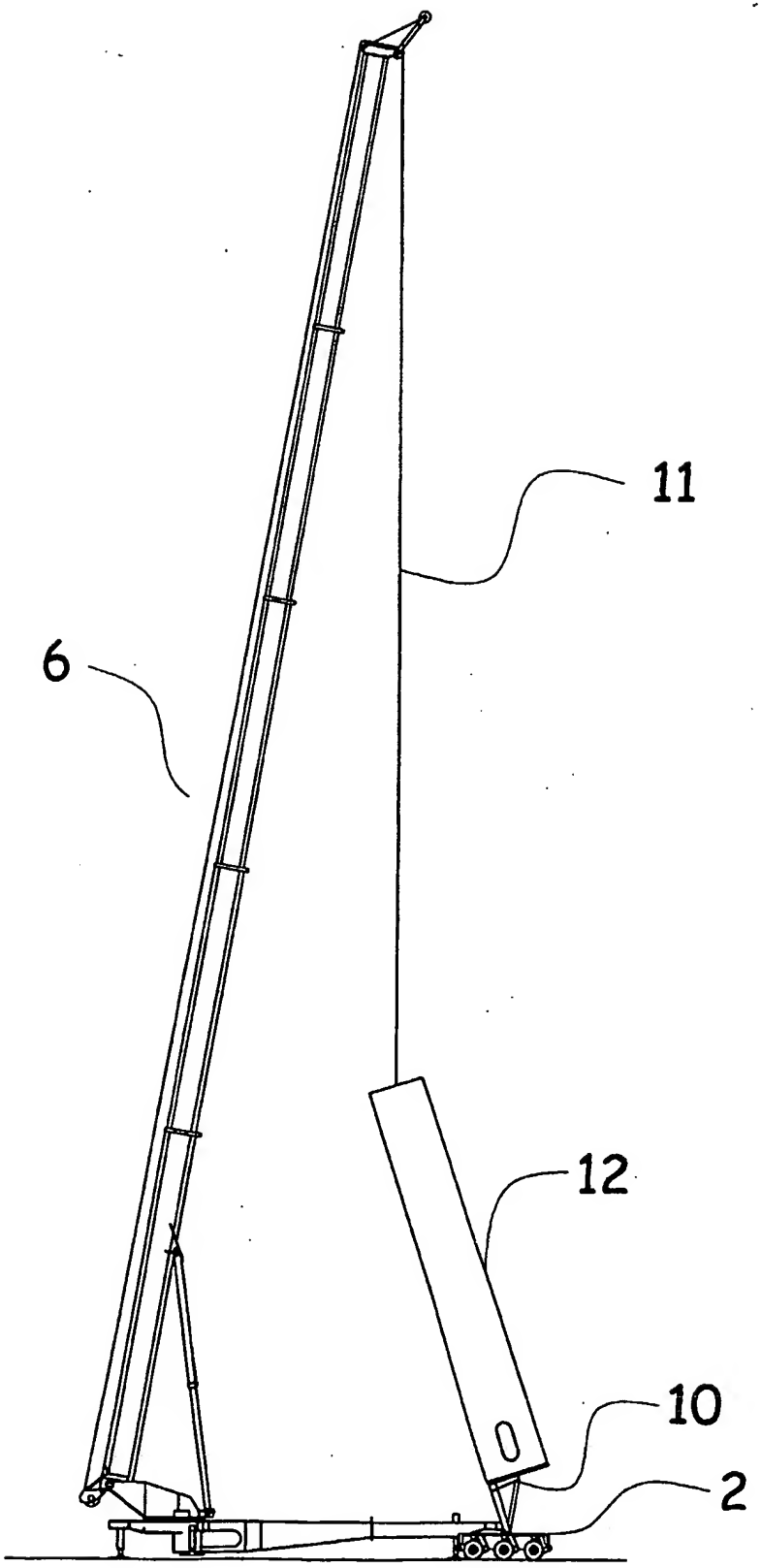

Fig. 11

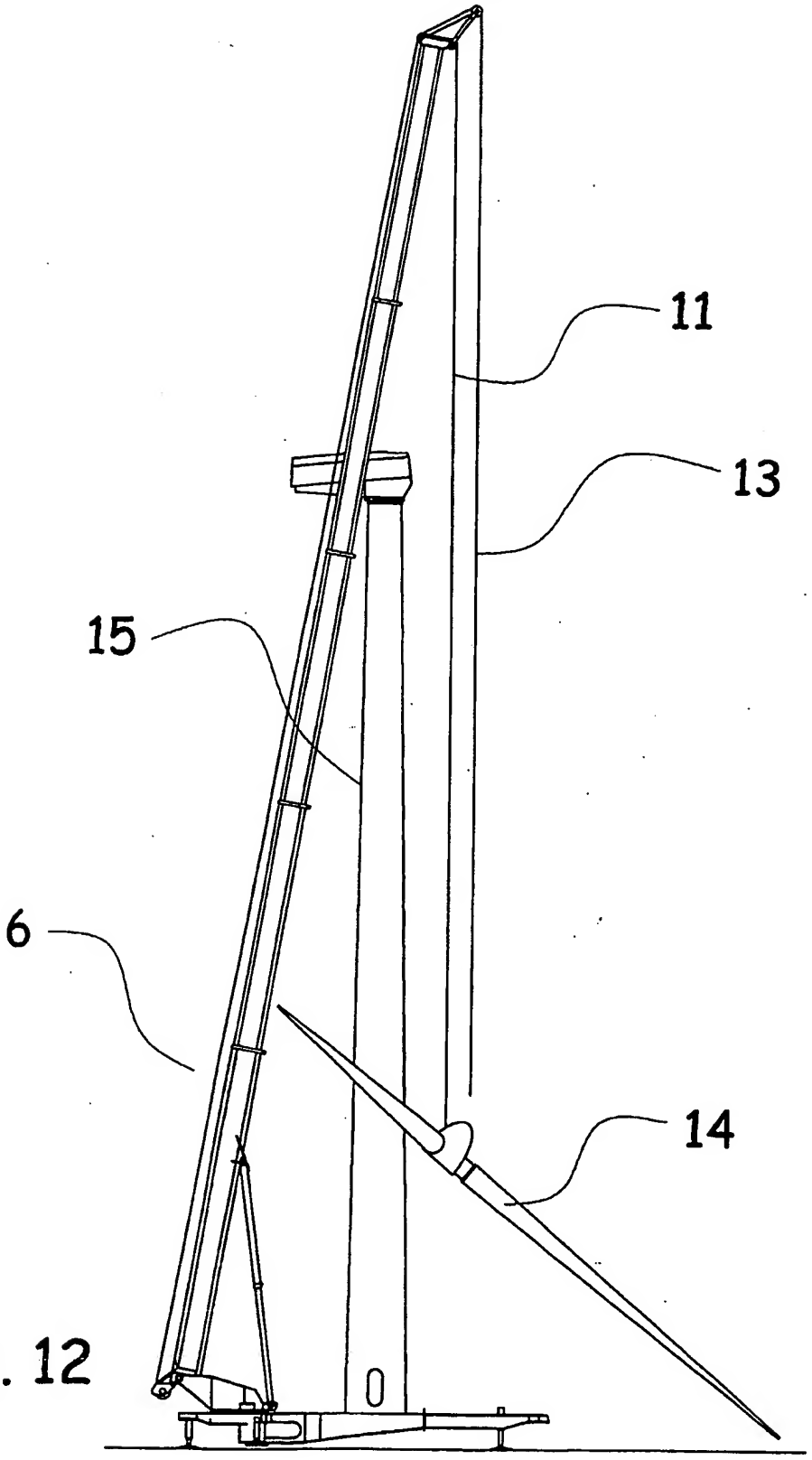

Fig. 12

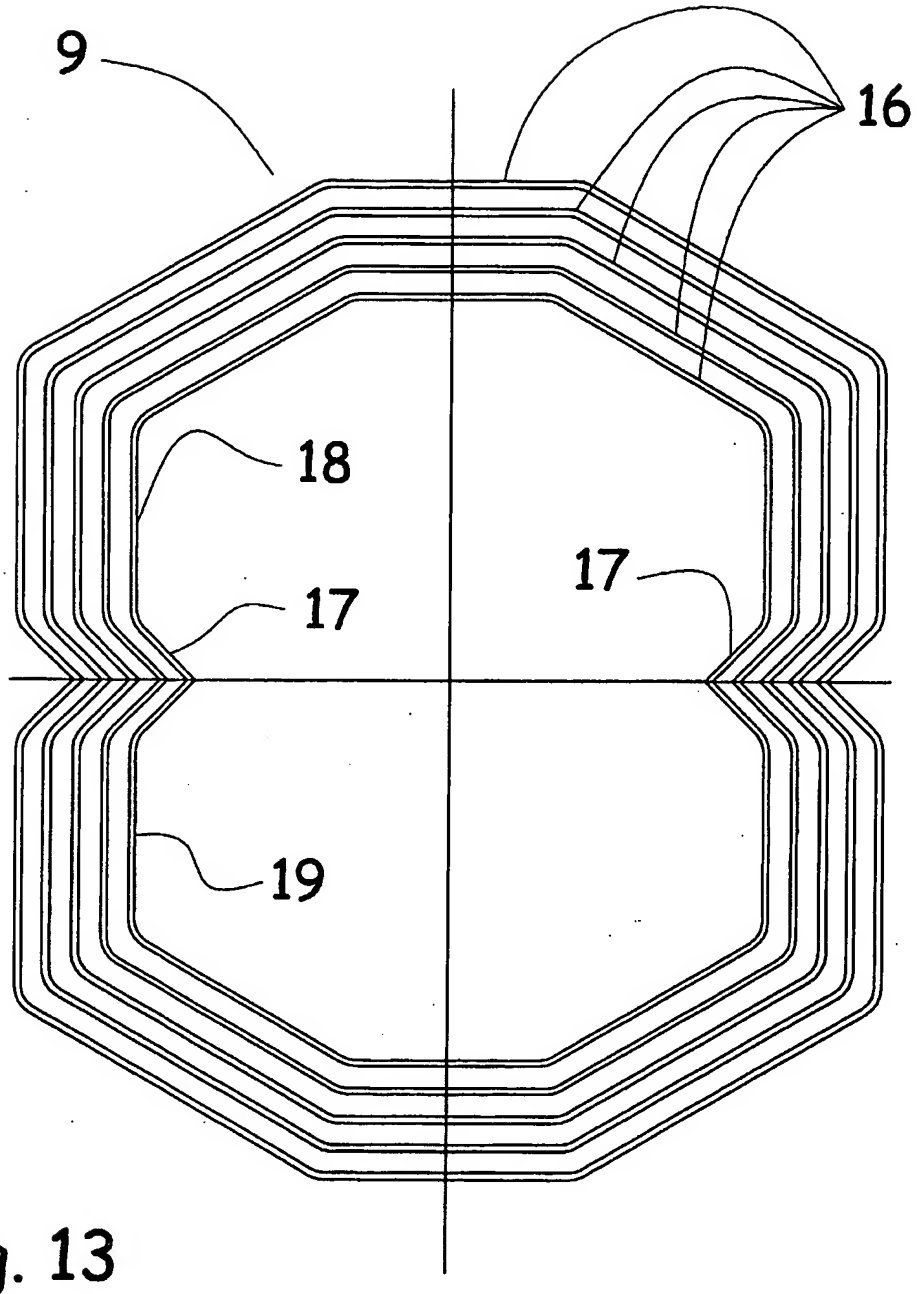

Fig. 13

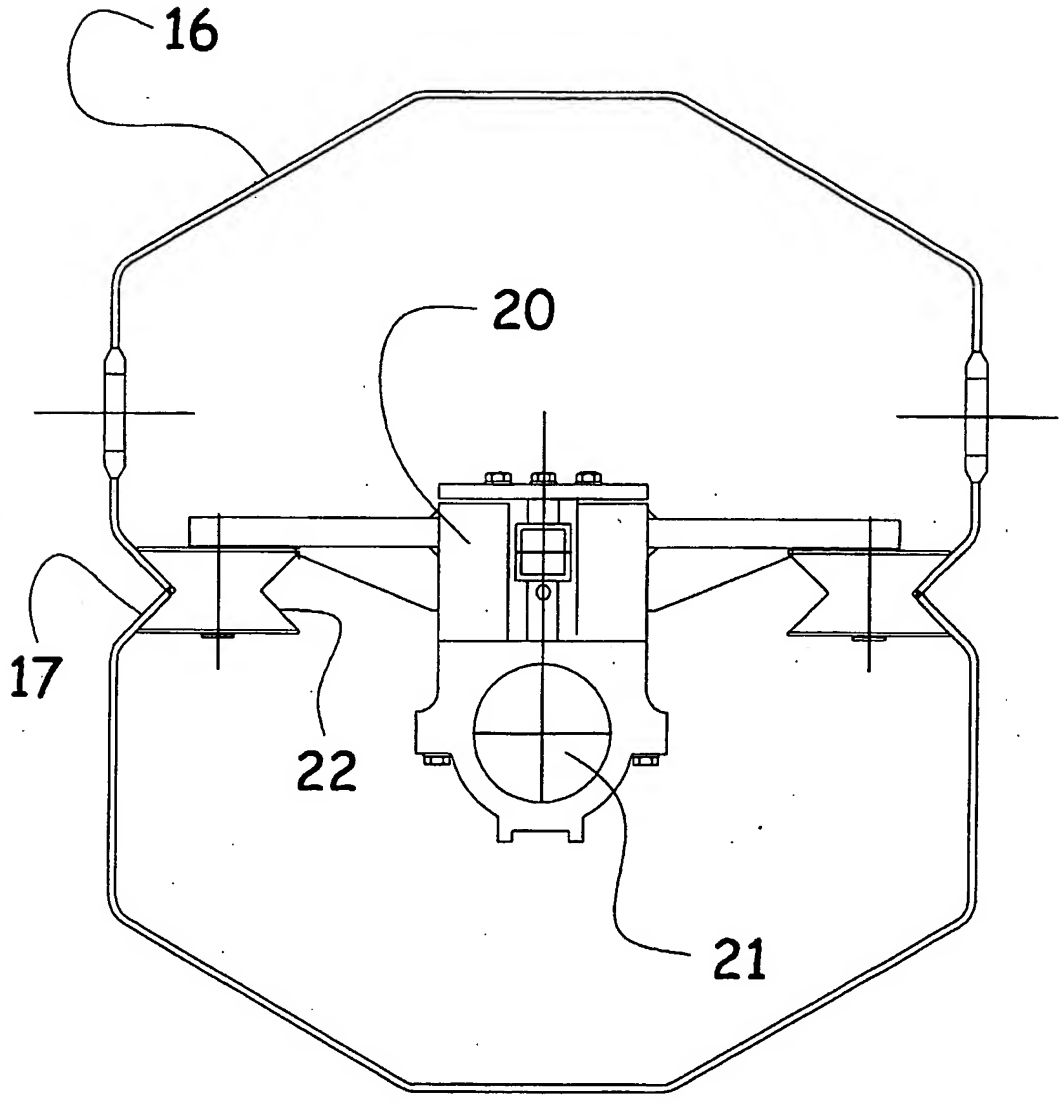

Fig. 14